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Implementation of a True Enterprise Web Based System to Manage Low Level, Mixed, Weapons Grade, Transuranic and Hazardous Waste at Lawrence Livermore National Laboratory

Jim Plunkett, David Haigh, John Collins, Jim Plunkett, David Haigh, John Collins

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IMPLEMENTATION OF A TRUE ENTERPRISE WEB BASED SYSTEM TO MANAGE LOW LEVEL, MIXED, WEAPONS GRADE, TRANSURANIC AND HAZARDOUS WASTE AT LAWRENCE LIVERMORE NATIONAL LABORATORY

Jim Plunkett, David Haigh
HazTrack®

John Collins
Lawrence Livermore National Laboratory

ABSTRACT

Faced with increasing challenges imposed by a new mixed waste treatment facility under construction, Lawrence Livermore National Laboratory (LLNL) embarked on a yearlong process of finding and implementing a new system to replace its existing waste tracking software. After a review of several applications, including the IWTS system in use at Idaho National Engineering and Environmental Laboratory (INEEL)^a, LLNL decided to implement HazTrack®. HazTrack® represents a new generation of browser based enterprise level business applications that are replacing the hardcoded client-server software that has been so prevalent for the last 15 years. It is widely believed that the object-oriented application frameworks of these applications, such as the model view controller (MVC) framework for HazTrack® will be at the core of leading-edge software technology in the twenty-first century. MVC applications adapt more readily to changes in business and technical requirements than do applications built using traditional programming techniques, anywhere from 2.5 to 12 times faster than propagating the same changes to programmatically implemented solutions. Because of this ability, the HazTrack team was able to rapidly modify the HazTrack application for management of radiological waste storage, including support for an unlimited number of dose conversion factors (DCF's) for calculation of Plutonium Equivalent (Pu-Eq) curies, nuclide tracking, nuclide distribution tracking, and storage area limits management. LLNL also required extensive security management features including a waste approval process with lockdown and audit trail capability that was also incorporated during the implementation, as well as a flexible access control architecture to facilitate customized user views and access rights to functions based on user groups. HazTrack® supports the full range of waste handling activities including waste generation, characterization, storage, treatment, and disposal through its fully configurable data model. The application also directly supports inventory management functions with a unique location hierarchy tree, allowing users to drill into whatever level of detail they desire with respect to inventory analysis. The ability to be able to rapidly customize the system allowed the HazTrack® team to respond to all of LLNL's business process requests in a reasonable time frame. This advanced design provides a software solution that is uniquely poised to deliver value today, and for many years to come.

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INTRODUCTION

Lawrence Livermore National Laboratory's (LLNL) new Decontamination and Waste Treatment Facility (DWTF) is an integrated facility for storing and processing the Laboratory's wastes, whether they be hazardous, low-level radioactive, transuranic radioactive, or mixed. More than 20 years in the making, DWTF has just recently gone into operation and will provide safe, cost-effective waste operations that will broaden Livermore's overall internal waste management capabilities. Faced with a complexity of EPA and DOE regulations relative to DWTF and also increased scrutiny over security for hazardous and radioactive wastes, LLNL's management knew that their existing database would not be able to do what they needed. They also knew that because the system was hardcoded and built with an Ingres database, which is no longer internally supported (designed in 1992 and initially rolled out in 1994), it would take a substantial effort to make the changes they desired. After determining that it would be more speedy and cost-effective to purchase rather than to build, LLNL embarked on a yearlong project and identified what they considered were all of the applicable systems in the market. HazTrack[®] was selected over several applications, including the IWTS system in use at Idaho National Engineering and Environmental Laboratory (INEEL), because it was based on an open architecture (Java 2EE), it was a thin client application requiring no software installation on

desktop machines, it was based on an Oracle data model consistent with the standard database engine in use at LLNL, and it supported custom configuration of not only waste characterization properties, but custom properties for virtually all aspects of the application. HazTrack was also selected based on the fact that its framework allowed for rapid customization and integration with other LLNL systems

During the design of the radiological characterization functions, special emphasis was placed on a solution that not only delivered what LLNL management desired, but also based on the user being able to configure the software to deliver that solution. For example, support for radiological limits necessitated calculating activity as plutonium equivalent curies (Pu-Eq Ci), which was accomplished by building in support for an unlimited number of Dose Conversion Factors and allowing the user to assign the DCF of their choice when calculating Pu-Eq Ci values.

HAZARDOUS WASTE MANAGEMENT

Haztrack was designed as an enterprise hazardous management and tracking system. The application supports all aspects of hazardous operations including: offsite approval and tracking of profiles (including costing) - for multiple vendors; inventory management including lab pack, storage tank and treatment system tracking; automatic generation of documentation including manifests, NESHAP certifications and annual and biennial reports and hazard class tracking for emergency response incidents. In addition, HazTrack's security access was extended to meet Lawrence Livermore's stringent requirements (described below).

Much of hazardous waste management involves tedious and repetitive documentation of wide array of information including EPA and State waste codes, DOT shipping names and hazard classes, transporter information, TSDF information etc. A key aspect to the application is timesaving features such as pre-populating container waste information from profiles when they are created, and the ability to copy and create containers from the same waste stream.

In addition, HazTrack has incorporated logic so that once containers are selected, it automatically knows which documents (manifests, LDR's, NESHAP certifications etc.) to generate (based on the generator and disposal facility) and does so automatically. HazTrack is based on an Oracle database and uses Oracle report server so that these documents can be delivered as PDF files via email or directly spooled to dedicated printers.

Truly, HazTrack has enabled a system to eliminate repetitive and time-consuming tasks so that the return on investment (see below) is so substantial it cannot be ignored.

RADIOLOGICAL WASTE MANAGEMENT

When the HazTrack project started, HazTrack did not directly support radiological properties. The initial steps were to create a master table of nuclides and their properties such as atomic weight, half-life, specific activity, fissile gram equivalent, thermal loading, and a flag to indicate if the nuclide was a TRU nuclide. Next, discussions with operations indicated that not only were individual nuclides characterized, but that several 'common distributions' were also

characterized. These distributions were items with names like natural uranium (Nat-U), weapons grade plutonium, and depleted uranium. HazTrack was modified to allow the creation of any number of these distributions, assigning individual nuclides to the distribution and defining their contribution to the distribution (its ratio).

HazTrack allows each waste to be described by not only the activity associated with individual nuclides present, but also the activity associated with the distributions. The total activity, normalized to micro-Ci, for each individual nuclide is maintained behind the scenes in the data base records to alleviate rounding issues and to facilitate reporting. At this point, HazTrack was able to deliver more functionality than LLNL's existing software system that never provided support for nuclide distributions.

As the HazTrack solution for LLNL evolved and the quantification of activity levels at each storage location was possible, it was determined that we needed to be able to support the calculation Pu-Eq Ci to compare against the facility SAR limits. Since the Pu-Eq Ci numbers are sensitive to the Dose Conversion Factor (DCF) that was utilized when the SAR was completed, HazTrack was modified to provide support for DCFs. With support for DCFs, HazTrack could calculate the Pu-Eq Ci activity for storage locations. Support was then added to allow the user to set radiological limits at any location within the facility. The limits could be for total activity and/or individual nuclide activity established by DOE. Indeed, HazTrack was also modified so that activity associated with distributions could be excluded from the activity calculations (e.g., exclude Nat-U activity).

Haztrack also supports DOE's Threshold limits for Nuclides and their corresponding calculations. These are defined in DOE-STD-1027-92 Attachment 1.

LLNL now has real time, web based access to check on the activity associated with its locations and to compare that activity with its limits imposed by DOE and/or SAR limits.

SECURITY, ACCESS CONTROL, AND APPROVAL

Waste characterization is ultimately at the cornerstone of all waste handling operations; however, the process of describing a waste often stretches across multiple groups and can often span a considerable amount of time. HazTrack, being an enterprise application, imposes no pre-designed constraints on this process, but rather lets the administrator assign access rights to user groups so as to fit with their organizations needs.

LLNL was able to meet its organizational security needs by restricting user access privilege levels right down to the individual page level based on the Haztrack concept of User Groups (e.g, one set of users may have full authority to edit chemical constituents, but have only view authority for EPA Waste Codes). Indeed, because of the nature of the application, a users access rights to the same waste characterization data may be different from one use of that data to the next (e.g., a user may have rights to edit waste codes on waste 'profiles', but have only view rights for waste codes associated with on site treatment tanks).

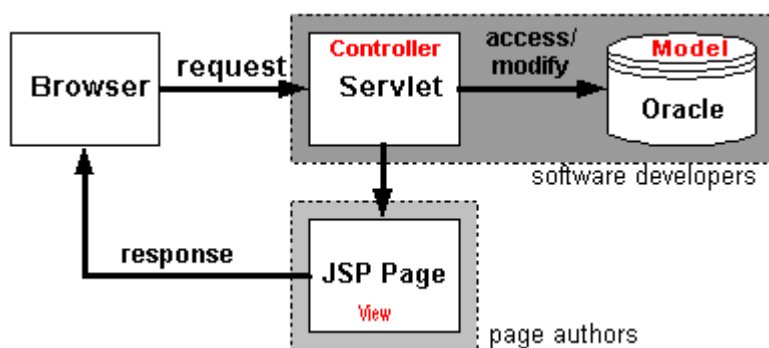
In addition to overall user access rights to data, LLNL has strict policies regarding who, when and how a waste is finally determined to be fully characterized. HazTrack supports, but does not require, a waste review/approval process. LLNL was able to leverage off this functionality to create a group of approval chemists, and grant the rights to review/approve wastes to those assigned to this group. The approval chemists can then review waste characterization data, and decide if the waste is fully/properly characterized, and if so they can then ‘lock’ the waste so that no one can modify the data.

The waste characterization process at LLNL changes from time to time, and the nature of HazTrack allows us to respond to those changes with configuration settings rather than having to revise the software.

RAPID CHANGE POSSIBLE WITH MVC ARCHITECTURE

One of the reasons LLNL decided to utilize HazTrack was that it was built on open software engineering standards. The HazTrack project has born out the validity of that decision, as the number of changes to the software necessary to support radiological waste properties, as well as suggested improvements and enhancements could be quickly acted upon and delivered. HazTrack is built on a Model-View-Controller paradigm (MVC), with a meta data layer (configurable from within the application) which provides the mapping between events and actions.

Figure 1 MVC Architecture



The MVC software design model is widely recognized as being more adaptable to changes in business and technical requirements than are traditional programmatically implemented solutions. Indeed, industry studies have shown MVC based systems propagate changes 2.5 to 12 times faster than traditional programmatically driven client/server designs^b. Our experience with HazTrack at LLNL would confirm the upper end of that range, as in many cases changes were implemented in a matter of a few days rather than the months normally associated with such changes.

INDIVIDUALIZED INTERFACE ON EVERY PAGE

The HazTrack application comes with what the software developer calls its ‘data view’, which is utilized through out the application wherever there are large lists of records for the user. The data view allows the user to customize their view of the data. Importantly, this customization is

‘persistent’, so that when the user returns to that page, their settings are remembered and the data is shown as it was when they left.

The customization includes the basics like being able to hide columns, change the label of the columns, change the data alignment, and even change the order in which the columns appear. However, the data view does not stop there, it is also a sort of an ad-hoc query tool as well by allowing the users to set filters on each column and sort by any column. The ability of each user to modify their view of the data on each page means that they can customize the way the application works for them to fit their needs, and their efforts to set up the filters, sorts and formatting are persistent so that they can continue to utilize their settings from session to session.

Desktop integration is also a snap because the data view supports a ‘spreadsheet’ button so that with the click of a button the data in the data view is placed into a popup page that is an excel spreadsheet allowing the user to then integrate that data into their other activities.

Importantly, each of the data view pages is based on a SQL View object, which of course can easily be modified as LLNL has done, and the data view automatically adjusts to those changes without any need to recode the application. Flexibility, individualization and extensibility seem to be built into every page providing the end users with unparalleled access to their data.

CUSTOMIZABLE WASTE PROPERTIES

Waste characterization implies that there is a clearly established set of properties that need to be captured. LLNL had clearly established policies, procedures, forms and processes which taken in total, encompassed potentially hundreds of different waste properties. When the HazTrack project began, the universe of waste properties that needed to be captured and supported by the software was significant in both its number and type. HazTrack provides support for the major properties of waste characterization, as well as a generic custom property feature:

Table 1 Waste Characterization Properties

HazTrack Waste Characterization Properties

Physical Properties	Chemicals
Other Properties (y/n type questions)	Constituents
Metals (total/tclp/stlc)	Waste Codes
Incineration Properties	Biennial Report Codes
Chemical Compatibility Codes	Waste Types (e.g., Universal, Mixed, etc)
Custom Properties (user defined)	Shipping Names
Radionuclides	Custom Radiological Properties
Information Source (e.g. gen. knowledge)	Quantification Method (activity levels)

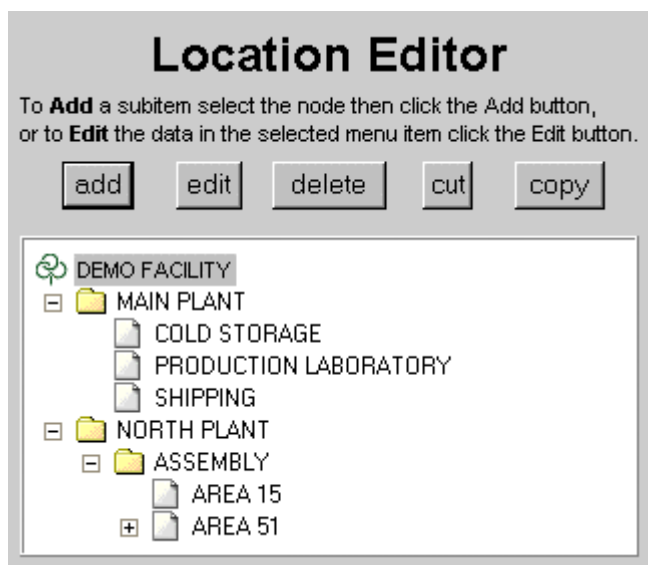
LLNL was able to utilize the administrative customization features of the HazTrack to meet its waste characterization needs. Indeed, as the project went forward and new properties were identified that needed to be captured, the properties were simply added to the application from the configuration interface, and were immediately available for use. HazTrack’s built in support for custom properties includes support for not only text fields, but also date, numeric and data

that is based on a pick list. This flexibility allowed us to create the waste properties we needed, including the ability of its pick lists to support the selection of multiple items for those “select all that apply” type of properties.

INVENTORY MANAGEMENT MADE SIMPLE

LLNL, like most facilities, is organized into various ‘levels’ of hierarchy. For us the levels roll up to ‘Segments’ at which we have established SAR and DOE limits for radionuclide activity. Within the segments we have buildings and within some buildings we may also have separate waste accumulation areas. At the lowest level are the 'scannable' locations that usually equate to a permitted area. Inventory management in HazTrack is based on the concept of these organization hierarchies by representing the inventory locations in the familiar ‘tree’ structure.

Figure 2 Location Editor



HazTrack comes with a ‘location editor’ in its administrative configuration section that allows you to edit the location tree directly. This allows you to manage your location hierarchy, seeing it in the same way you will access inventory data. The very same tree appears on the inventory page, allowing users to select any level within the tree and HazTrack reports the inventory at that node and below that node (automatically including the concept of a hierarchy in the data reported to the user). At LLNL this allows us to quickly ascertain the activity within a segment, and to also drill down to the individual building levels with the click of a mouse.

The users interact with the inventory by clicking on the inventory tree, which refreshes the data into a ‘data view’ table based on their select. Because of the data view, the current inventory is always just a click away from being in an excel spreadsheet for calculations, reporting, and or email. No more complex queries/reports are needed to check on inventory, just point and click. And again, this data view can easily be customized -as LLNL has done.

OFFSITE SHIPMENTS

Inventory management is just one of the daily tasks necessary to the smooth operation of the LLNL. The preparation of off site shipments of waste is also a critical element. HazTrack allows us to create 'pending' shipments to which we can assign containers from inventory, or simply create shipment items for things not in inventory. The 'available' containers from inventory are filtered based on their having a valid off-site approval (vendor profile approval), a valid shipping name, and having not already been assigned to another off-site shipment. This logic is intended to prevent people from scheduling the wrong waste for shipment.

Printing the documents necessary for a shipment is a snap. HazTrack's configuration features allows you to assign manifest templates (reports) to the destination TSDF (e.g., a CA manifest for Clean-Harbors, San Jose facility), so there is no need to ask the user what manifest to print, HazTrack already knows what documents to print. All those miscellaneous documents (e.g., land ban certifications, benzene NESHAP certifications, asbestos certifications, etc...) that are necessary are also known to HazTrack because of the off site approval for the wastes, and so HazTrack always includes all these documents in its shipping documents printing as well.

HazTrack is designed to send the user all of the necessary shipping documents as attachments to an email that describes the attachments and provides instructions on what to do with the attachments (e.g., print on CA manifest form). Manifests are transmitted as PDF files so they print correctly on dot matrix printers, and the balance of the shipping documents are sent in their original file formats (e.g., .jpeg, .gif, .pdf, .doc, etc...). All the documents are in one place with one set of instructions. For generators who have dedicated a printer to printing manifests, HazTrack also supports spooling the manifest print directly to the printer so not only do you get the email, but the manifest document is sent directly to your printer.

REPORTING

Perhaps the biggest problem with software designed to both support and control waste handling operations is with reporting. Users are constantly changing their requests for everything from labels to printed reports to spreadsheet reports. Rather than assume a 'fixed' set of reports that a user might request (e.g., profiles by waste type, inventory by age, etc...), HazTrack provides users with access to virtually all of their information directly through the data view connection.

For specific reporting needs, such as labels, printed certifications that require signatures, etc., reports will always be necessary. Keeping with the flexible nature of the application design, HazTrack supports an administrative feature called report mapping. Basically, with HazTrack you can create virtually any report you wish, and then 'map' that report template to any page within the application. When a user clicks on the print button on that page, the reports that are mapped to that page are made available to the user. The user then selects the report(s) they wish to run and the application runs the report and emails the result to the user. Once again, in some cases you may have a dedicated printer for certain reports (e.g., labels), so the report template may be mapped to directly spool to that printer rather than being sent as an attachment to an email.

No preset report limits, and the ability to access reporting from virtually any page within the application, provide for a virtually unlimited amount of flexibility in reports provided to the end users.

HazTrack automatically generates the required EPA biennial reports in both electronic and printed (pdf) formats. Recognizing that not every automatically generated report will ever be perfect, the data from the automatic generation is fully editable by the user. The automatically generated data includes waste shipped off site, waste generated but not shipped, as well as waste received. On site treatment/disposal as well as off site treatment/disposal are of course also generated for each of the waste streams.

Biennial Reporting is never going to be a snap, but with HazTrack it is surly a lot easier than it has been in the past.

Links to PDA Scanners and Internal MSDS System

LLNL has found it easy to significantly extend Haztrack's capabilities by using existing or custom PL/SQL procedures to update Haztrack tables directly. One area in particular is the use of Handheld PDA Scanners. LLNL uses PDAs for a variety waste management functions including inventory movements, building shipments, treatment functions, and Labpacking. These transactions are then uploaded to Haztrack by calling PL/SQL procedures. In the future LLNL is looking to perform data input in the field with these PDAs and is also investigating a wireless solution.

Haztrack also provides a customizable link to a customer's internal MSDS system. This allows automatically populating chemical and other pertinent info about an MSDS based waste from an internal tracking number saving significant amount of data input and possible data entry errors.

RETURN ON INVESTMENT (ROI)

As a result of implementing HazTrack, LLNL estimates they will save a substantial amount of money and will continue to do so over the next several years. The two largest areas of savings were development costs for a new system and administrative savings. Development costs for their existing system that Haztrack is replacing, were over \$15 million or \$1.5 million per year over a 10 year period of use.

Administrative savings will primarily be due to eliminating 2 positions dedicated to data input. The Field Techs that actually gather the data, now input the data directly into Haztrack.

IT Support savings will be from eliminating dedicated support personnel of old Ingres based system. Additional savings are from Haztrack's automation of the EPA/DTSC Annual Facility Report, which eliminates our manual process of producing report.

There estimated 5 Year ROI is as follows:

Annual Project Savings

- | | |
|------------------|------------|
| • Administrative | \$ 150,000 |
| • IT Support | \$ 200,000 |

- IT Development \$2,500,000
- Services Contractor \$ 0
- Waste Reduction \$ 100,000
- Audits \$ 50,000

Total Annual Project Savings \$3,000,000

Total Project Cost \$750,000

Payback Period 3 months

5 year ROI \$11.25 million (2,268%)

These figures are projections only.

CONCLUSION

The HazTrack project at LLNL has seen major improvements in the ability of the computations group to support the waste operations group as well as given the waste operations group the ability to improve the way they conduct their daily work. The HazTrack Team has proven to be a great partner in helping to move the LLNL from its existing information structure to one that not only supports current operations, but has the ability to support future operations as well.

^a R.S. Anderson, "The Integrated Waste Tracking System a Flexible Waste Management Tool" WM 01 Conference, March 2001

^b TransWorld Resources Incorporated www.twresources.com